WHITE PAPER NO. 13 – HUDSON RIVER RECORD OF DECISION
PCB NON-CANCER HEALTH EFFECTS WHITE PAPER

Response to a Review of

DRAFT BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT
FOR THE LOWER FOX RIVER AND GREEN BAY, WISCONSIN
REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

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The white paper contained in this attachment was prepared as part of the Record of Decision for the Hudson River in New York. The topic of focus – PCBs as non-carcinogens – has relevance to the Lower Fox River and Green Bay site and the response to comments received on the Baseline Human Health and Ecological Risk Assessment and are defended by WDNR and EPA.

PCB NON-CANCER HEALTH EFFECTS (ID362704)

ABSTRACT

Non-cancer health effects associated with exposure to PCBs include reduced birth weight, learning problems, and reduced ability to fight infection. The quantification of non-cancer health effects is a Reference Dose, which is a dose below which non-cancer health effects are not expected to occur over a lifetime. EPA has established guidelines for evaluating non-cancer health effects and developing Reference Doses for chemicals. These guidelines were externally peer reviewed. Using these guidelines and associated documents, EPA developed a Reference Dose for Aroclor 1016, which was externally peer reviewed. EPA used the same methodology to develop a Reference Dose for Aroclor 1254, which was internally peer reviewed. EPA's Reference Dose for Aroclor 1254 is consistent with the chronic Minimal Risk Level for PCBs developed by the Agency for Toxic Substances and Disease Registry. EPA is currently updating the non-cancer toxicity information for PCBs contained in the Integrated Risk Information System, which is the Agency's consensus database of toxicity information.

In the Human Health Risk Assessment for the Hudson River PCBs Site, EPA summarized recent studies published since 1994, including studies on developmental/neurotoxic effects, thyroid and immunological effects, reproductive effects, and neurological effects in adults. Based on a review of these studies, EPA determined that it was appropriate to use the current Reference Doses for PCBs in the Human Health Risk Assessment. EPA submitted the Human Health Risk Assessment for external peer review, and the peer reviewers agreed with the toxicity values used in the Human Health Risk Assessment.

INTRODUCTION

The purpose of this paper is to provide an overview of EPA's process for evaluating the noncancer toxicity of a chemical, development of non-cancer Reference Doses (RfDs) for PCBs, and the application of this toxicity information in the Human Health Risk Assessment for the Hudson River PCBs Site.

This paper is divided into three parts. The first part describes EPA's non-cancer guidelines and background documents for developing reference doses (RfDs) (USEPA,

1986a-b, 1991, 1992, 1993a,b, 1996a, 1998). These documents set forth principles and procedures for evaluating noncancer toxicity information.

The second part of this paper describes the Agency's evaluation of the non-cancer toxicity of PCBs. It summarizes the important studies regarding PCB non-cancer toxicity, including the critical studies identified for development of the Reference Doses in the Integrated Risk Information System (IRIS), the Agency's consensus database of toxicity information. The third part describes the non-cancer toxicity information used in the Human Health Risk Assessment for the Hudson River PCBs Site and addresses the Averaging Times and blood PCB levels from occupational studies.

EPA'S NON-CANCER GUIDELINES AND REFERENCE DOSE DEVELOPMENT

EPA's process for evaluating human epidemiological and animal evidence to determine the noncancer toxicity of chemicals, including PCBs, is set forth in the Agency's guidelines (USEPA, 1986a-b, 1991, 1992, 1993a, 1996a, 1998) and supporting information (USEPA, 1993b; Barnes and Dourson, 1988; Dourson and Stara, 1983). The guidelines cover a variety of health endpoints including developmental toxicity (USEPA, 1991), reproductive toxicity (USEPA, 1996a), neurotoxicity (USEPA, 1998), female reproductive risk (USEPA, 1986a) and male reproductive risk (USEPA, 1986a).

The non-cancer toxicity guidelines were developed within the Agency and published in the Federal Register for comment. Periodically, the guidelines have been updated to reflect new scientific understanding regarding toxicity. Prior to being finalized, the guidelines, as updated, are externally peer reviewed by a panel of expert scientists in the various fields associated with non-cancer toxicity including developmental toxicity, neurological toxicity, endocrine effects, who work in universities, environmental groups, industry, labor, and other governmental agencies. EPA responds to comments on the draft guidelines and makes changes based on a review of the comments submitted by these groups or individuals. The guidelines are also submitted for review to EPA's Science Advisory Board, an external scientific review panel.

Reference Dose Development

The quantification of chronic non-cancer health effects is a chronic Reference Dose (RfD), which is defined as an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of an exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA, 1989, 1993b).

The procedures used by EPA to develop RfDs are provided in the Background Document on RfD Development available on EPA's IRIS database (USEPA, 1993b; see also www.epa.gov/iris). In general, exposure to a given chemical, depending on the dose, may result in a variety of toxic effects ranging from death to subtle biochemical, physiologic, or pathologic changes. The process for RfD development includes:

- Critical evaluation of the available scientific literature, including human epidemiological and animal toxicity studies. Human data are often useful in

qualitatively establishing the presence of an adverse effect in exposed human populations. Human epidemiological studies may be limited in their ability to establish a dose-response relationship between level of exposure and observed health effects, by the degree to which confounders (e.g., other chemicals and lifestyle factors) are controlled.

- For many chemicals, the principal studies are drawn from experiments conducted on nonhuman mammals, such as the rat, mouse, rabbit, guinea pig, hamster or monkey. These animal studies typically reflect situations in which exposure to the chemical has been carefully controlled and the problems of heterogeneity of the exposed population and concurrent exposures to other chemicals have been minimized.

- EPA uses a weight-of-evidence approach in evaluating the non-cancer toxicity of a chemical, with emphasis on the results from the principal and supportive studies. Identification of the critical study(s), critical effect(s) and a dose level (i.e., no observed adverse effect level [NOAEL] or lowest observed adverse effect level [LOAEL]) based on the study(s). The dose level is then divided by uncertainty factors to calculate an RfD. In general, the values used for each uncertainty factor are either 1, 3, or 10 (USEPA, 1993b). The value of 3 is used as a "half" factor and represents the square root (rounded to one significant digit) of the full uncertainty factor of 10, so that two "half" factors yield a full factor of 10 when multiplied together (USEPA, 1994b).

- There are four standard uncertainty factors (ranging from 1 to 10) that can be used when calculating an RfD. These factors account for 1) the variation in sensitivity among members of the human population, 2) extrapolation from animal data to humans, 3) extrapolation from less than chronic NOAELs to chronic NOAELs, and 4) extrapolation from LOAELs to NOAELs. An additional modifying factor (MF), also ranging from 1 to 10, can be applied to the calculation of the RfD. The magnitude of the MF depends upon an assessment of the scientific uncertainties of the study and the database used in deriving the RfD that are not explicitly treated above, such as completeness of the overall database and the number of species tested.

The equation used in the calculation is:

$$RfD = NOAEL \div (UF \times MF).$$

NON-CANCER TOXICITY OF PCBS

Based on a weight of the evidence, EPA concluded that PCBs pose a non-cancer health hazard. Non-cancer health effects associated with exposure to PCBs include dermal effects (e.g., chloracne), developmental neurotoxic effects (e.g., learning problems), ocular effects (eye problems), reduced birth weight, and immunotoxic effects (e.g., reduced ability to fight infection). This conclusion is based primarily on animal studies, including monkey studies. Human evidence was also considered.

EPA is not alone in its concern regarding the non-cancer toxicity of PCBs and in using data from studies in monkeys to develop health protective toxicity values. In a joint publication with EPA, ATSDR stated (ATSDR and USEPA, 1996):

> "The findings of elevated PCB levels in human populations, together with findings of developmental deficits and neurologic problems in children whose mothers ate PCB-contaminated fish, have compelling implications. The weight of evidence clearly indicates that populations continue to eat fish containing PCBs and that significant health consequences are associated with consumption of large amounts of some fish...Human health studies...indicate that: 1) reproductive function may be disrupted by exposure to PCBs; 2) neurobehavioral and developmental deficits occur in newborns and continue through school-aged children who had in utero exposure to PCBs; 3) other systemic effects (e.g., self-reported liver disease and diabetes, and effects on the thyroid and immune systems) are associated with elevated serum levels of PCBs; and 4) increased cancer risks, e.g., non-Hodgkin's lymphoma, are associated with PCB exposures."

The National Research Council (NAP, 2000) concluded:

> "The Committee's review of recent scientific information supports the conclusion that exposure to PCBs may result in chronic effects (e.g., cancer, immunological, developmental, reproductive, and neurological effects) in humans and/or wildlife. Therefore, the committee considers that the presence of PCBs in sediments may pose long-term public health and ecosystem risks."

Dermal Effects

Several studies document dermal effects in workers exposed to PCBs (Fischbein et al., 1979, 1982, 1985; Maroni et al., 1981a,b; Ouw et al., 1976; Smith et al., 1982). Dermal effects include skin rashes, pigmentation disturbances of skin and nails, thickening of the skin, burning sensations, and chloracne, a severe form of acne that results from exposure to PCBs. Variability in response in more highly exposed individuals suggests that susceptibility varies greatly among individuals (ATSDR, 2000).

Studies in Rhesus monkeys fed diets containing Aroclors for intermediate durations of exposure found effects including facial edema (swelling), acne, folliculitis (inflammation of the hair follicle) and alopecia (hair loss) (Allen and Norback, 1973, 1976; Allen et al. 1973, 1974a,b; Barsotti et al., 1976; Becker et al., 1979; Ohnishi and Kohno, 1979; Thomas and Hinsdill, 1978).

Developmental/Neurotoxic Effects

Developmental/neurotoxic effects associated with PCB exposure in animals and identified in human epidemiological studies include reduced birth weight, learning problems, and memory problems.

On September 14 and 15, 1992, EPA convened a Risk Assessment Forum (RAF) Colloquium of expert scientists to evaluate the developmental/neurotoxic effects of PCB exposure. The Workshop papers discuss the principles and methods for evaluating data from animal and human epidemiological studies (USEPA, 1993a). The report concluded:

> "The sense of the meeting seemed to be that, at least in qualitative terms, the available data are sufficient. In other words, based on an evaluation of the strengths and weaknesses in the data and on the consistency of effects seen in all species tested, including humans, there is sufficient

information to indicate that PCBs cause developmental neurotoxicity. Interestingly, the data suggest that prenatal exposure to PCBs may be more detrimental than postnatal exposure, even though the level of exposure via breast milk is much greater than that occurring via placental transfer."

Similarly, ATSDR's Toxicological Profile for PCBs (ATSDR, 2000) stated:

"Studies in humans who consumed high amounts of Great Lakes fish contaminated with environmentally persistent chemicals, including PCBs, have provided evidence that PCBs are important contributors to subtle neurobehavioral alterations observed in newborn children and that some of these alterations persist during childhood...Neurobehavioral alterations have been also observed in rats and monkeys following pre- and/or postnatal exposure to commercial Aroclor mixtures, defined experimental congener mixtures, single PCB congeners, and Great Lakes contaminated fish. In addition, monkeys exposed postnatally to PCB mixtures of congeneric composition and concentration similar to that found in human breast milk showed learning deficits long after exposure had ceased."

Immunotoxic Effects

The immune system is the body's primary defense against infection. Immune effects associated with PCBs include a reduced ability to fight infections. Several human epidemiological studies evaluated the effects of PCBs on workers and found transient effects on total and differential white blood cell counts (Chase et al., 1982; Lawton et al., 1985; Maroni et al., 1981b; Smith et al., 1982). A number of studies have evaluated the effects of PCBs in specific population groups (i.e., infants, children of mothers who consumed fish, and fish consumers). Immunotoxic effects reported in the Great Lakes populations include increased middle ear and respiratory tract infections in children of exposed mothers (Smith, 1984).

ATSDR (2000) concluded:

"Findings include increased susceptibility to respiratory tract infections in adults and their children, increased prevalence of ear infections in infants, decreased total serum Immunoglobulin A and Immunoglobulin M antibody levels, and/or changes in T lymphocyte subsets. Overall there is a consistent of effects among the human studies suggesting sensitivity of the immune system to PCBs, particularly in infants expose in utero and/or via beast feeding. However, due to the mixed chemical nature of the exposures and generally insufficient information on exposure-response relationship, the human studies provide only limited evidence of PCB immunotoxicity."

Decreased antibody responses (Immunoglobulin G and Immunoglobulin M) were detected in studies on monkeys (Tryphonas et al., 1989, 1991a,b).

Ocular Effects

Occupational studies have shown eye irritation, tearing and burning among workers exposed to airborne PCBs (Emmett et al., 1988, Ouw et al., 1976; and Smith et al., 1982). Fischbein et al. (1979, 1985) found that some capacitor workers had edema of the upper eyelid, congestion of the conjunctiva, eye discharge and enlargement of the Meibomian glands following exposures to various Aroclors in a range of concentrations.

The monkey studies noted ocular exudate (discharge) and inflamed and enlarged Meibomian glands (Arnold et al., 1993a, b).

Reference Doses for Aroclors 1016 and 1254

Using the process summarized above, EPA evaluated both human epidemiological evidence and animal toxicity studies in developing quantitative RfDs for Aroclors 1016 and 1254 (USEPA, 1999a,b).

EPA determined that the human data available for risk assessments of Aroclor 1016 and Aroclor 1254 are useful only in a qualitative manner, noting, "Studies of the general population exposed to PCBs by consumption of contaminated food, particularly neurobehavioral evaluations of infants exposed in utero and/or through lactation, have been reported, but the original PCB mixtures, exposure levels and other details of exposure are not known (Kreiss et al., 1981; Humphrey, 1983; Fein et al., 1984a,b; Jacobson et al., 1984a,b, 1985, 1990a,b; Rogan et al., 1986; Gladen et al., 1988). Most of the information on health effects of PCB mixtures in humans is available from studies of occupational exposure. Some of these studies examined workers who had some occupational exposure, but in these studies concurrent exposure to other Aroclor mixtures nearly always occurred, exposure involved dermal as well as inhalation routes (the relative contribution by each route was not known), and monitoring data were lacking or inadequate (Fischbein et al., 1979, 1982, 1985; Fischbein, 1985; Warshaw et al., 1979; Smith et al., 1982; Lawton et al., 1985)."

A brief summary of EPA's development of the RfDs is provided below.

Aroclor 1016

EPA identified the monkey reproductive studies by Barsotti and van Miller (1984) and neurological studies by Levin et al. (1988), and Schantz et al. (1989, 1991) as critical studies. The critical effect identified was reduced birth weights. A NOAEL of 0.25 ppm in feed (or 0.007 mg/kg-day) was identified. The IRIS chemical file for Aroclor 1016 summarizes the critical study and effect and describes EPA's evaluation of a number of other studies that provide supporting information for the selection of these studies (USEPA, 1999a; see also www.epa.gov/iris).

As part of EPA's peer review process, on May 24 and 25, 1994, EPA convened an RAF Workshop to assess whether the Reference Dose (RfD) for Aroclor 1016 (USEPA, 1994a) represents a full consideration of the available scientific data and whether that analysis is clearly articulated in the RfD entry on IRIS. The results from this Workshop were used in finalizing the Responsiveness Summary Hudson River PCBs Site Record of Decision PCB Non-Cancer Health Effects-7 RfD for Aroclor 1016 (USEPA, 1999a) currently listed on IRIS. The IRIS chemical files for both Aroclor 1016 (USEPA, 1999a) and Aroclor 1254 (USEPA, 1999b) represent the consensus of the Reference Dose/Reference Concentration Workgroup, responsible for reaching consensus on non-cancer toxicity values, which was in existence when the files were completed. USEPA's applied uncertainty/modifying factors totaling 100 (3 x 3 x 3 x 3 and rounded) to be protective of sensitive human populations that may be exposed i.e., the NOAEL of 0.007 mg/kg-day was divided by a factor of 100 to yield a RfD of 0.00007 mg/kg-day. A summary of the UFs and their basis is provided below:

- A factor of 3 is applied to account for sensitive individuals. The results of these studies, as well as data for human exposure to PCBs, indicate that infants exposed transplacentally represent a sensitive subpopulation.

- A factor of 3 is applied for extrapolation from Rhesus monkeys to human. A full 10-fold factor for interspecies extrapolation is not considered necessary because of similarities in toxic responses and metabolism of PCBs between monkeys and humans and the general physiologic similarity between these species. In addition, the Rhesus monkey data are predictive of other changes noted in human studies such as chloracne, hepatic changes, and effects on reproductive function.

- A factor of 3 is applied because the study duration was considered as somewhat greater than subchronic, but less than chronic; a partial factor of 3 is used to account for extrapolation from a subchronic exposure to a chronic RfD.

- A factor of 3 is applied because of limitations in the database. Despite the extensive amount of animal laboratory data and human epidemiologic information regarding PCBs, the issue of male reproductive effects is not directly addressed and two-generation reproductive studies are not available.

Aroclor 1254

EPA identified the monkey studies by Arnold et al. (1993a,b), Tryphonas et al. (1989, 1991a,b) as the critical studies. The critical effects were ocular exudate, inflammation and prominent Meibomian glands in the eye, distorted growth of finger- and toenails, and decreased antibody responses (Immunoglobulin G and Immunoglobulin M) based on responses to sheep erythrocytes (USEPA, 1999b). A NOAEL could not be identified so a LOAEL of 0.005 mg/kg-day was identified.

EPA applied uncertainty factors totaling 300 (i.e., 10 x 3 x 3 x 3 and rounded) to the LOAEL of 0.005 mg/kg and calculated an RfD of 0.00002 mg/kg-day. The basis for the UFs are provided below:

- A factor of 10 is applied to account for sensitive individuals such as children, elderly, and others.

- A factor of 3 is applied to extrapolation from Rhesus monkeys to humans. A full 10-fold factor for interspecies extrapolation is not considered necessary because of similarities in toxic responses and metabolism of PCBs between monkeys and humans and the general physiologic similarity between these species. Tilson et al. (1990) reported that humans appear to be more sensitive than monkeys or rodents. EPA noted that the differences in species sensitivity may be related to variations in the sensitivity of the testing paradigms used in different species, and/or differences in the toxicity of the various commercial mixtures, or environmental exposures used in various studies (USEPA, 1993a). Based on similarity in types of effects but dissimilarity in effective doses and NOAELs across test species, EPA concluded that monkeys are not less sensitive than humans with respect to developmental/neurotoxic effects of PCBs (USEPA, 1993a).

- A factor of 3 is applied for the use of a minimal LOAEL since the changes in the periocular tissues and nail bed seen at the 0.05 mg/kg-day are not considered to be of marked severity. The duration of the critical study continued for approximately 25% of the lifespan of Rhesus monkeys, so a factor of 3 is appropriate for extrapolation from subchronic exposure to a chronic RfD.

- A factor of 3 is applied based on the immunologic and clinical changes that were observed but did not appear to be dependent upon duration, which further justifies using a factor of 3 rather than 10 for extrapolation from subchronic to chronic, lifetime exposure. The Agency for Toxic Substances and Disease Registry issued an updated Toxicological Profile for Polychlorinated Biphenyls following external peer review (ATSDR, 2000). ATSDR (2000) includes Minimal Risk Levels (MRL). The MRL is defined as "an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure" (ATSDR, 2000). The chronic MRL is developed to be protective over a one-year period or more, and is similar to EPA's RfD, which is developed to be protective over a lifetime. The intermediate MRL is developed to be protective from 15 to 364 days.

ATSDR's chronic MRL is 0.00002 mg/kg-day, based on the study by Tryphonas et al. (1989, 1991a,b), which also was used as the critical study for EPA's RfD for Aroclor 1254. The intermediate oral MRL level developed by ATSDR based on monkey studies by Rice (1997, 1998, 1999b) and Rice and Hayward (1997 and 1998) is 0.00003 mg/kg-day, which is slightly higher than the MRL for chronic exposure (ATSDR, 2000). Similar to EPA, ATSDR used a factor of 3 for extrapolating from the monkey studies to humans in developing its MRLs.

HUDSON RIVER PCBS SITE

Consistent with EPA guidance and CERCLA and NCP policies, the PCB non-cancer toxicity information and RfDs that are in IRIS were used in the HHRA (USEPA, 2000a,b). The use of IRIS data in the evaluation of chemical toxicity at Superfund sites addresses EPA's goal of using consistent toxicity information at Superfund sites across the country.

EPA submitted the HHRA (USEPA, 1999c) for external peer review. EPA specifically charged the peer reviewers to evaluate whether use of the IRIS values was appropriate. The peer Responsiveness Summary Hudson River PCBs Site Record of Decision PCB Non-Cancer Health Effects-9 reviewers for the HHRA agreed with USEPA's use of non-cancer toxicity information from IRIS.

In the HHRA, EPA applied an Averaging Time that is equivalent to the Exposure Duration multiplied by 365 days/year, consistent with USEPA (1989). The peer reviewers of the HHRA agreed with EPA's selection of Averaging Times (USEPA, 2000b) and recommended that EPA evaluate the effects of PCBs to pregnant and nursing women using a shorter exposure duration. The non-cancer hazards to the fetus and infant were addressed qualitatively in the HHRA (USEPA, 2000a), due to the lack of an

approved methodology for modeling the effects of PCBs on the fetus and calculating the PCB levels in breast milk based on the mother's body burden.

The HHRA peer reviewers also recommended that EPA also provide a discussion of the more recently published studies on non-cancer endpoints to determine what effect these studies might have on risk estimates. In response, in the Revised HHRA, EPA summarized a number of newly published human epidemiological studies on the non-cancer effects of PCBs (including updates of the neuro-developmental studies in cohorts of children and adults) identified in the IRIS files for Aroclors 1016 and 1254 (USEPA, 2000a). Based on an evaluation of this data, EPA concluded that the toxicity values in IRIS are still appropriate for the HHRA (USEPA, 2000b).

Since 1994, a number of new animal studies and human epidemiological studies and updated studies of the cohorts originally described in 1993-1994 have been published (e.g., Rice 1997, 1998, 1999b, Rice and Hayward, 1997, 1998; Schantz, 1996, Schantz et al., 2001; Jacobson and Jacobson, 1996a,b; 1997; Lanting et al., 1998a,b,c; Patandin et al., 1998, 1999a,b; Koopman-Esseboom et al., 1996; Weisglas-Kuperus et al., 1995, 2000; and Fitzgerald et al., 1995, 1996, 1998, 1999). The studies have been published in a variety of peer-reviewed journals (e.g., Neurotoxicology, New England Journal of Medicine, Science, Lancet, Environmental Health Perspective, Journal of Pediatrics), including a number of public health and epidemiological journals (American Journal of Public Health, Annals of Epidemiology, Epidemiology, American Journal of Epidemiology). In general, as the studies progressed through time, the list of confounders were expanded or reduced as appropriate based on a priori information regarding previous studies, consistent with epidemiological practices. A summary of these studies is provided the HHRA (USEPA, 2000a).

Some of these studies found reductions in IQ points (i.e., 3 to 5 points across the various studies) based on prospective studies in children exposed to various sources of PCBs, including fish consumption. At a population level, as well as at an individual level, the potential impacts of the loss of IQ points may be significant, especially among children at the low end of the IQ distribution.

As part of EPA's reassessment of PCB non-cancer toxicity, EPA will critically evaluate this new information (e.g., from human epidemiological studies, animal studies, and mechanistic data) to determine the critical study, critical effect, and appropriate Uncertainty/Modifying Factors necessary to develop a new RfD or reaffirm the current RfD. Documents summarizing the noncancer toxicology of PCBs will be reviewed within the Agency, and submitted for external peer review. Based on the results of this review, an IRIS chemical file will be developed and undergo internal EPA consensus IRIS review, and will be made available on the IRIS database at the completion of this process.

Effects of PCB Exposure on Blood Levels

EPA followed risk assessment guidance and procedures (see National Contingency Plan; see also USEPA, 1989, 1993c, 1995, 1997) to quantify non-cancer health hazards to individuals exposed to PCBs at the Hudson River PCBs Site in the HHRA (USEPA,

2000a). The approach used in the HHRA is different than measurement of PCB levels in blood of former capacitor workers.

First, the HHRA evaluates current and future exposures, while the blood PCB level data integrates past exposure. Second, capacitor workers were primarily exposed through dermal contact and inhalation of PCBs, whereas anglers, which had the highest cancer risks evaluated in the HHRA, would be exposed to PCBs through ingestion of contaminated fish caught in the Hudson River. Third, in the HHRA EPA evaluated non-cancer health hazards to the RME individual, whereas for capacitor workers the level of exposure is generally not known. Fourth, the PCB congener profile in the capacitor plant is likely to be different from the congener profile of PCBs that are bioaccumulated in the fish. Lastly, EPA is concerned with potential exposures to the human population including sensitive groups that may include the fetus exposed from mothers who consumed PCB-contaminated fish, infants exposed to PCBs through breast milk, young children, adolescents, adults, and individuals with pre-existing medical conditions (USEPA, 2000a); many of these sensitive groups may not be represented in a healthy worker population. EPA has stated that (USEPA, 1996b):

> "People with decreased liver function, including inefficient glucuronidative mechanism in infants, can have less capacity to metabolize and eliminate PCBs (Calabrese and Sorenson, 1977). Additionally, approximately 5% of nursing infants receive a steroid in human milk that inhibits the activity of glucuronyl transferase, further reducing PCB metabolism and elimination (Calabrese and Sorenson, 1977)."

A study of people exposed through eating contaminated fish (Hovinga et al., 1992) suggests that the PCB mixtures in fish can be more persistent than those to which the workers were exposed. From 1977 to 1985, mean PCB serum levels (quantified using Aroclor 1260 as a reference standard) from 111 Great Lakes fish eaters decreased only slightly from 20.5 to 19.0 ppb (see USEPA, 1996b). Half-life estimates for a mixture can underestimate its long-term persistence (USEPA, 1996b), especially from consumption of fish where changes in PCB blood levels may take longer (Hovinga et al., 1992). This indicates that the rate of decline in the fish eating populations will be slower than that for the workers.

ATSDR's Toxicological Profile (ATSDR, 2000) states that there are no known treatment methods for reducing body burdens of PCBs, concluding that limiting or preventing further exposure appears to be the most practical method for reducing PCB body burdens.

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